Draft document

Training Guide for Explosive Analysis Training

This training guide is a **suggested** guideline for the training of a new examiner in the field of explosive analysis. It may be modified to fit an agency's training requirements.

All training should include proper documentation upon completion of each section/module).

• Introduction

Introduction to Explosives

Objectives:
Upon completion of this unit the student will be able to:

1. Describe with the historical development of explosives. (*i.e.* black powder, TNT, smokeless powder, Nitroglycerin, pyrotechnics, etc.)
2. Describe the different types of explosives and how they are classified into low and high explosives.
3. Explain how explosives are used. (*i.e.* blasting, propellants, military, pyrotechnic, clandestine, etc.)

Practical exercises:

None

Method of Instruction:
1. Instruction by trainer
2. Self study.

Method of Evaluation:
- Achieve a minimum score of 80% on a written test covering the above-mentioned topics.

Suggested readings:

Davis, TL. The Chemistry of Powder and Explosives, Angriff Press, Hollywood, CA. ISBN 0913022-00-4.

Weingart, GW. Pyrotechnics, Angriff Press, Hollywood, CA.

• Chemical Testing Procedures

Physical tests for Explosives

Color Spot Tests for Explosives

Objectives:
Upon completion of this unit the student will be able to:

1. Correctly perform a color test for various cations and anions.

2. Correctly perform a color test for various explosives (e.g., TNT, RDX, etc.) and explosive components (e.g., sulfur, aluminum).

3. Understand the interfering substances and limitations of each spot color test used.

4. Where possible, describe the chemical reaction of the color test.

Practical Exercises:

1. Using various oxidizers, fuels, and high explosives perform relevant color spot tests.

2. Using various standards of post blast products perform relevant color spot tests.

3. Using some of the various oxidizers, fuels, post blast products, and several non-explosive component chemicals, perform the same tests

Method of Instruction

1. Reading literature
2. Practical exercises
3. Instruction from trainer.

Method of Evaluation

Written examination, oral questioning, and successful completion of qualifying samples. *A qualifying sample is one or more samples provided to the trainee establishing that the trainee can successfully complete the module, through relevant analytical technique(s).*

Suggested readings:

Davis, TL. The Chemistry of Powder and Explosives, Angriff Press, Hollywood, CA. ISBN 0913022-00-4, Chapter 3 Pyrotechnics.

Weingart, GW. Pyrotechnics, Angriff Press, Hollywood, CA.
Chapters 1, 3, & 5

4. THIN LAYER CHROMATOGRAPHY

Objectives:
Upon completion of this unit the student will be able to:

1. Be familiar with practical thin layer chromatography.

2. Demonstrate the different response times for different high explosives.

3. Extract smokeless powder particles for nitroglycerine.

4. Demonstrate the order of visualization reagents for developing explosives.

Practical exercises:

1. Utilizing at least six smokeless gunpowders to include four morphologically different smokeless gunpowders, run three different TLC systems on each.

2. Develop each using at least three different visualizing sprays.

3. Determine the components present in each and compare to literature data.

4. Utilizing at least six different types of high explosives to included TNT, RDX and PETN, run three different TLC systems on each.

5. Develop each using at least three different visualizing sprays.

Method of Instruction
Reading literature, practical exercises, and instruction from trainer.

Method of Evaluation
Written examination, oral questioning, and successful completion of qualifying samples. A qualifying sample is one or more samples provided to the trainee establishing that the trainee can successfully complete the module, through relevant analytical technique(s).

5. Microscopy of Explosives

Basic Microscope Knowledge

Objective:
Upon completion of this unit the trainee will be able to:

1. Name the important parts of a stereomicroscope and polarizing light microscope.
2. Explain the basic theory of optics, resolution, and how magnification is achieved.
3. Describe basic theory of polarized light microscopy and optical crystallography.
4. Setup and align any of the light microscopes used in the examination and analysis of explosives.

Practical Exercises:

1. Properly setup a stereomicroscope.
2. Properly setup and align a transmitted light microscope (e.g. Kohler illumination).

Method of Instruction:

1. Trainer will demonstrate the setup and alignment of microscopes and the trainee will then setup and align microscopes with the trainer present.
2. Self study

Method of Evaluation:

Discussion and observation.

References:
McCrone, McCrone and Delly, Polarized Light Microscopy (**Lee will provide proper reference)**

Microscopical Preparations of Inorganic Oxidizers

Upon completion of this unit the trainee will be able to:
1. Prepare known samples of common inorganic oxidizers for microscopical examination by polarized light microscopy (PLM).
2. Determine and recognize the optical crystallographic properties of the common organic oxidizers.

Practical Exercises:
1. Prepare temporary and/or permanent microscopical mounts for all the common inorganic oxidizers. This should include at least the following: NH4NO3, NaNO3, KNO3, KClO3, KClO4, Ba(NO3)2and NH4ClO4.
2. Examine the microscopical mounts and note the characteristic optical crystallographic properties such as morphology, refractive index (indices), interfacial angles, crystal system, birefringence, optic angle, and optic sign for each of the common inorganic oxidizers.

Method of Instruction:
3. Trainer will demonstrate mounting techniques and will review the characteristic optical crystallographic properties of the common inorganic oxidizers with the trainee.
4. Self Study

Method of Evaluation:
Discussion and observation.

References:

Winchell, A. N. and H. Winchell, The Microscopical Characters or Artificial Inorganic Solid Substances: Optical Properties of Artificial Minerals, Academic Press, New York, NY, (1964). **Thom will provide updated reference.**

Polarized Light Microscopy, McCrone, McCrone and Delly.
"Fusion Methods Identification of Inorganic Explosives", John H. Kilbourn and Walter C. McCrone, The Microscope, Second quarter 1985, Vol. 33, No. 2.

McCrone, W. C., and J. G. Delly, The Particle Atlas, Volume I and II, Second Edition, Ann Arbor Science Publishers, (1973).

Water recrystalization method of inorganic oxidizer identification:

Objective: Upon completion of this unit the trainee will be able to:

1.Recognize common inorganic oxidizers through water recrystalization

Practical Exercises:

1. The trainee shall recrystalize known reference standards of common inorganic oxidizers. This should include at least the following: NH4NO3, NaNO3, KNO3, KClO3, KClO4, Ba(NO3)2and NH4ClO4.
2. .During recrystalization the trainee should note the optical crystallographic properties of each compound

Method of Instruction:

3. Trainer will demonstrate recrystalization method and the trainee will perform the recrystalization with the trainer present.
4. Self study

Method of Evaluation:

1. The trainee will be given unknown samples and will correctly identify the oxidizer using the water recrystalization method.
2. Discussion and observation

Reference:
"Characterization and Identification of Water Soluble Explosives", Thomas J. Hopen and John H. Kilbourn, The Microscope, First quarter 1985, vol 33, no. 1.

Fusion method of identification of inorganic oxidizers

Objective: Upon completion of this unit the trainee will be able to:

1.Recognize common inorganic oxidizers by using the fusion method.

Practical Exercises:

1.Recrystalize from melts of reference standards of common inorganic oxidizers, this should include at least the following: NH4NO3, NaNO3, KNO3, KClO3, KClO4, Ba(NO3)2and NH4ClO4.

2. The trainee should note the optical crystallographic characteristics of the fusion preparation during and after recrystalization.

Method of Instruction:

1. Trainer will demonstrate the fusion method and the trainee will perform the fusion method with the trainer present.

2. Self study

Method of Evaluation:

1. The trainee will be given unknown samples and will correctly identify the oxidizer using the fusion method.

2. Discussion and observation

Reference:

"Fusion Methods Identification of Inorganic Explosives", John H. Kilbourn and Walter C. McCrone, The Microscope, Second quarter 1985, Vol. 33, No. 2.

Microchemical Crystal Tests

Objective: Upon completion of this section the trainee will be able to:

1.Recognize cations and anions found in common oxidizers.

2.Perform microchemical tests to identify commonly encountered cations and anions

Practical Exercises:

1. Perform microchemical tests on oxidizers to determine the cations, using the corresponding reagents. These should include

K+	Chloroplatinic acid
NH4+	Chloroplatinic acid
NH4+	Chloroplatinic acid (hanging drop test)
Na+	zinc acetate/uranyl acetate
Various cations	Squaric acid

2. Perform microchemical tests on oxidizers to determine the anions, using the corresponding reagents. These should include

NO3-	Nitron
ClO4-	Methylene Blue, Nitron, or Strychnine Sulfate
ClO3-	Nitron or Methylene Blue

Evaluation:

1. The trainee will conduct a water extraction of pyrotechnic material (to include Black Powder, Pyrodex, and flash powder) and perform the microchemical crystal tests on the water wash residue.
2. The trainee will perform the microchemical crystal tests on burned residue to identify the anion and cations.

Method of Instruction:

1. Trainer will demonstrate the fusion method and the trainee will perform the fusion method with the trainer present.
2. Self study

Method of Evaluation:

1. The trainee will be given unknown samples and will correctly identify the anions and cations using the microchemical crystal tests.
2. Discussion and observation

Reference:

"Characterization and Identification of Water Soluble Explosives", Thomas J. Hopen and John H. Kilbourn, The Microscope, First quarter 1983, Vol. 33, No. 1.
"An Introduction to Microchemical Qualitative Analysis" Skip Palenik, Handbook of Chemical Microscopy, Volume II, Emile Chamot and Clyde Mason, John Wiley and Sons, New York, 1940.
"Methylene Blue Microchemical Test for the Detection and Identification of Chlorates and Perchlorates", Thomas J. Hopen and James B. Crippin, The Microscope, First quarter 20001, Vol 49.

Identification of organic high explosives

Objective: Upon completion of this unit the trainee will be able to:

1. Recognize common organic high explosive by fusion preparations

Practical Exercises:

Examine the following preparations and note the characteristic optical crystallographic properties such as morphology, refractive index (indices), interfacial angles, crystal system, birefringence, optic angle, and optic sign for each:

1. Direct preparation:
   Prepare temporary and/or permanent microscopical mounts for organic high explosives such as, but not limited to: TNT, PETN, HMX, RDX and/or a mixture of HMX/RDX (e.g.: C4).
2. Fusion:
   A. Single:

Prepare a fusion melt for organic high explosives such as, but not limited to: TNT, PETN, Tetryl, and HMX.

B. Mixed:
Prepare a mixed fusion melt for organic high explosives such as, but not limited to: TNT/ Ammonium Nitrate (e.g.: Amatol), Picric Acid/ Thymol, and TNT/RDX (e.g.: Composition B or Military Dynamite).

C. Sublimation:
Sublime organic high explosives such as, but not limited to: HMX and RDX.

3. Re-crystallization from a solvent:
Re-crystallize organic high explosives from appropriate solvents such as, but not limited to: HMX in acetone, RDX from nitromethane, and picric acid from ethanol/water (1:1).

Method of Instruction:

1. Trainer will demonstrate the above method and the trainee will perform the fusion method with the trainer present.
2. Self study

Method of Evaluation:

1. The trainee will be given unknown samples and will correctly identify the high explosive using the fusion method.
2. Discussion and observation

Reference:

"Identification of Organic High Explosives", Walter C. McCrone, Jack H. Andreen, Sien-Moo Tsang, The Microscope, 1993.

Small Particle Handling

Objective:
Upon completion of this unit the trainee will be able to:

1) Manipulate increasingly smaller particles using the naked eye and stereomicroscope.
2) Perform microcrystal, microchemical, and fusion on increasingly smaller particles.

Practical exercises:

1) Perform microchemical, microcrystal, and fusion on increasingly smaller particles.
2) Perform microchemical tests on one particle of Black Powder and Pyrodex. Repeat for microcrystal tests and fusion.
3) Perform all three techniques (microcrystal, microchemical, and fusion) on particles of Black Powder and Pyrodex.

Method of Instruction:

1. Trainer will demonstrate the small particle handling and the trainee will handle small particles with the trainer present.
2. Self study

Method of Evaluation:

1. The trainee will be given increasingly smaller particles and will successfully perform microchemical, microcrystal and fusion on the particles.
2. Discussion and observation.

References:
Thom will provide references. Teetsov, Teetsov, Teetsov.

6. Instrumentation

(Note: The trainee will only be required to pass sections on instrumentation that they have access to. They should however review material on analysis techniques that are currently unavailable to them.)

Infrared Spectroscopy (IR/FTIR)

Objectives:

Upon completion of this unit the student will be able to:

1. Explain the basic theory and instrumentation used in IR.
2. Compare and contrast dispersive and Fourier transform IR (FTIR).
3. Discuss the and applications of available IR/FTIR.
4. Explain and be able to perform appropriate calibration procedures and/or quality checks and routine instrument maintenance.
5. Discuss the strengths and limitations of the technique.
6. Prepare samples for analysis, choosing the technique most appropriate to the sample. Interpret the results obtained, using library searches or comparison to known standards and/or spectral subtraction when appropriate.

Practical exercises:

1. Diagram the components of the instrument available in your laboratory, and explain the function of each component. This should include, but not necessarily

be limited to, the energy source, the optics and the detector.

2. Perform all appropriate calibration and/or quality checks before using the instrument.

3. Analyze common explosive materials and combustion products using all appropriate IR accessories available, and compare the results obtained, ease of analysis, and benefits of each technique.

Analyze samples from many types of explosive available, to include black powder and post-combustion black powder, black powder substitutes, and other explosives commonly encountered.

Method of Instruction:
1. Lecture
2. Self-study
3. Demonstrations
4. Practical exercises

Method of Evaluation:
Written or oral quiz (80% passing score required)
Evaluation of practical exercises

Gas Chromatography (GC)

Objectives:
Upon completion of this unit the student will be able to:

1. Explain the basic theory and instrumentation used in GC.

2. Compare and contrast column types and sizes used in GC.

3. Discuss the and applications of available GC.

4. Explain and be able to perform appropriate calibration procedures and/or quality checks and routine instrument maintenance.

Practical exercises:

1. Diagram the components of the instrument available in your laboratory, and explain the function of each component.

2. Perform all appropriate calibration and/or quality checks before using the instrument.

3. Analyze known explosive components such as NG, NC, nitromethane, fuel oil,

and other suitable materials

4. Analyze at least five unknown samples by GC, run spectral library searches or comparison to standards, and discuss the limitations of the interpretation.

   Method of Instruction:
   1. Lecture
   2. Self-study
   3. Demonstrations
   4. Practical exercises

   Method of Evaluation:
   Written or oral quiz (80% passing score required)
   Evaluation of practical exercises

Gas Chromatography /Mass Spectrometry (GC/MS)

Objectives:
Upon completion of this unit the student will be able to:

1. Explain the basic theory and instrumentation used in GC/MS

2. Discuss the available sample introduction and ionization techniques

3. Explain and be able to perform appropriate calibration procedures and/or quality checks and routine instrument maintenance.

4. Be able to explain the strengths and limitations of the technique.

5. Interpret the results obtained, using library searches or comparison to known standards

Practical exercises:

1. Diagram the components of the instrument available in your laboratory, and explain the function of each component.

2. Perform all appropriate calibration and/or quality checks before using the instrument. Evaluate and document results.

3. Analyze samples from each type of appropriate explosive available, to include smokeless powder, high explosives, and other appropriate materials.

4. Analyze at least five unknown samples by GC/MS, run spectral library searches or ion profiling as appropriate and discuss the limitations of the interpretation.

Method of Instruction:

1. Lecture
2. Self-study
3. Demonstrations
4. Practical exercises

Method of Evaluation:
Written or oral quiz (80% passing score required)
Evaluation of practical exercises

X-Ray Diffraction (XRD)

Objectives:
Upon completion of this unit the student will be able to:

1. Explain the basic theory and instrumentation used in XRD.

2. Explain and be able to perform appropriate quality checks and routine instrument maintenance.

3. Be able to explain how sample displacement, preferred orientation, amorphous substances, sample flatness and crystal size can influence the resulting diffraction pattern. Know how sample preparation can compensate for many of these, and be able to use several different sample preparation techniques.

4. Explain the strengths and limitations of the technique.

5. Prepare samples for analysis, utilizing non-routine methods when appropriate.

6. Interpret the results obtained, using library searches or comparison to known standards.

Practical exercises:

1. Diagram the components of the instrument available in your laboratory, and explain the function of each component.

2. Perform all appropriate quality checks before using the instrument. Evaluate and document results.

3. Analyze common explosive materials and combustion products using different sampling techniques available. Compare the results obtained, ease of preparation, and benefits of each technique.

4. Analyze samples from many types of explosive available, to include black powder and post-combustion black powder, black powder substitutes, and other explosives commonly encountered.

5. Analyze at least five unknown samples by XRD, run library searches, and discuss the limitations of the interpretation.

Method of Instruction:
1. Lecture
2. Self-study
3. Demonstrations
4. Practical exercises

Method of Evaluation:
Written or oral quiz (80% passing score required)
Evaluation of practical exercises

Scanning Electron Microscope / Energy Dispersive X-ray Spectrometry (SEM/EDS)

Objectives:
Upon completion of this unit the student will be able to:

1. Explain the basic theory and instrumentation used in SEM/EDS.

2. Explain and be able to perform appropriate calibration procedures and/or quality checks and routine instrument maintenance.

3. Discuss the strengths and limitations of the technique.

4. Discuss factors which may effect the resulting spectrum, such as escape peaks, sum peaks, peak overlaps, and peak ratio shifts in a spectrum.

5. Prepare samples for analysis, choosing the technique most appropriate to the sample.

6. Interpret the results obtained.

Practical exercises:

1. Diagram the components of the instrument available in your laboratory, and explain the function of each component. This should include, but not necessarily be limited to, the x-ray source, optics and the detector.

2. Perform all appropriate calibrations and/or quality checks before using the instrument. Evaluate and document results.

3. Analyze common explosive materials, combustion products and explosive device components available

4. Analyze at least five unknown samples by SEM/EDS, and discuss the limitations of

the interpretation.

Method of Instruction:
1. Lecture
2. Self-study
3. Demonstrations
4. Practical exercises

Method of Evaluation:
Written or oral quiz (80% passing score required)
Evaluation of practical exercises

High Pressure Liquid Chromatography (HPLC)/Ion Chromatography (IC)

Objectives:
Upon completion of this unit the student will be able to:

1. Explain the basic theory and instrumentation used in HPLC/IC.

2. Discuss sample preparation techniques..

3. Explain and be able to perform appropriate calibration procedures and/or quality checks and routine instrument maintenance.

4. Be able to explain the strengths and limitations of the technique and of the different detectors.

5. Prepare samples for analysis, choosing the technique most appropriate to the sample.

6. Interpret the results obtained in comparison to known standards.

Practical exercises:

1. Diagram the components of the instrument available in your laboratory, and explain the function of each component.

2. Perform all appropriate calibration and/or quality checks before using the instrument. Evaluate and document results.

3. Analyze water extracts from a variety of known explosive standards and explosive residues.

4. Analyze at least five unknown samples by HPLC/IC and compare to standards. Discuss the limitations of the interpretation.

Method of Instruction:
1. Lecture
2. Self-study
3. Demonstrations
4. Practical exercises

Method of Evaluation:
Written or oral quiz (80% passing score required)
Evaluation of practical exercises

EGIS

Objectives:
Upon completion of this unit the student will be able to:

1. Explain the basic theory of EGIS.

2. Explain and be able to perform appropriate calibration procedures and/or quality checks and routine instrument maintenance.

3. Be able to explain the strengths and limitations of the technique.

4. Interpret the results obtained in comparison to known standards.

Practical exercises:

1. Diagram the components of the instrument available in your laboratory, and explain the function of each component.

2. Perform all appropriate calibration and/or quality checks before using the instrument. Evaluate and document results.

3. Analyze a variety of known explosive standards and explosive residues.

4. Analyze at least five unknown samples by EGIS and compare to standards. Discuss the limitations of the interpretation.

Method of Instruction:
1. Lecture
2. Self-study
3. Demonstrations
4. Practical exercises

Method of Evaluation:
Written or oral quiz (80% passing score required)
Evaluation of practical exercises

X-Ray Fluorescence (XRF)

Objectives:
Upon completion of this unit the student will be able to:

1. Explain the basic theory and instrumentation used in XRF.

2. Explain and be able to perform appropriate calibration procedures and/or quality checks and routine instrument maintenance.

3. Discuss the strengths and limitations of the technique.

4. Prepare samples for analysis, choosing the technique most appropriate to the sample.

5. Interpret the results obtained.

Practical exercises:

1. Diagram the components of the instrument available in your laboratory, and explain the function of each component. This should include, but not necessarily be limited to, the x-ray source, optics and the detector.

2. Perform all appropriate calibrations and/or quality checks before using the instrument. Evaluate and document results.

3. Analyze common explosive materials, combustion products and explosive device components available

4. Analyze at least five unknown samples by XRF and discuss the limitations of the interpretation.

Method of Instruction:
1. Lecture
2. Self-study
3. Demonstrations
4. Practical exercises

Method of Evaluation:
Written or oral quiz (80% passing score required)
Evaluation of practical exercises

7. Chemistry of Explosives

Chemistry of Low Explosives-Commercially produced Black Powder/Black Powder Substitutes

Objectives:
Upon completion of this unit the student will be able to:

1. Recognize Black Powder and Black Powder substitutes, including particle sizes and morphologies.
2. Describe Black Powder and Black Powder substitute formulations.
3. Explain the Black Powder and Black Powder substitute combustion products.

Practical exercises:

1. Examine at least five samples of Black Powder and/or Black Powder substitutes, classify them by physical characteristics. This should include at least one Pyrodex sample

2. Make a list of the formulations of Black Powder and Black Powder substitutes.

3. Make a list of the combustion products of Black Powder and Black Powder substitutes.

4. Burn samples of at least three Black Powder and/or Black Power substitutes.

Method of Instruction:
- Instruction by trainer, self study.

Method of Evaluation:
- Examine at least five unknowns and classify them as Black Powder and/or Black Powder substitutes.

Suggested readings:

Davis, TL. The Chemistry of Powder and Explosives, Angriff Press, Hollywood, CA. ISBN 0913022-00-4, Chapter 3 Pyrotechnics.

Weingart, GW. Pyrotechnics, Angriff Press, Hollywood, CA.
Chapters 1, 3, & 5

Chemistry of low explosives-smokeless powder

Objectives:
Upon completion of this unit the student will be able to:
1. Recognize smokeless powder.

2. Describe the different morphologies and how they relate to speed of burn.

3. Describe the difference between single, double, and triple base smokeless powder.

Practical exercises:

1. Examine at least ten samples of Smokeless Powder classify them by physical characteristics. This should include at least one sample of each type of morphology.

2. Make a list of the formulations of Smokeless Powder.

3. Make a list of the combustion products of Smokeless Powder.

4. Burn samples of at least ten different types of Smokeless Powder.

Method of Instruction:

1. Instruction by trainer
2. Self study.

Method of Evaluation:

- Examine at least five unknowns and classify them as the type of Smokeless Powder.

Suggested readings:

Davis, TL. The Chemistry of Powder and Explosives, Angriff Press, Hollywood, CA. ISBN 0913022-00-4, Chapter 3 Pyrotechnics.

Weingart, GW. Pyrotechnics, Angriff Press, Hollywood, CA.
Chapters 1, 3, & 5

Chemistry of Low Explosives – Pyrotechnics

Objectives:
Upon completion of this unit the student will be able to:

1. Recognize that they have a pyrotechnic mixture and not black powder or smokeless powder.

2. Describe at least ten formulations of pyrotechnic mixtures.

3. Explain combustion products of pyrotechnic mixtures.

4. Describe possible uses of pyrotechnic mixtures based on their formulation. (for example, strontium nitrate, sulfur, and sawdust are consistent with road fusee or similar device)

5. Be able to describe methods of preparation of various pyrotechnic devices including but not limited to: sparklers, M-80's, firecrackers, Roman candles, whistling, stars, fountains, and how to achieve flames of different color.

Practical Exercises:

1. By direct visual examination and a stereomicroscope, examine at least ten powders from pyrotechnic devices.

2. Make a list of formulations from the literature of at least 20 pyrotechnic devices including, but not limited to, flash powder, Armstrong's mixture, firecrackers, railroad fusee, road flare, cones/fountains, piccolo/whistling Pete, sparklers, Roman candle and its contents, torpedo/snap pops, smokes & gopher gases, etc.

3. .Using microscopical, instrumental, and other analytical techniques, identify components present in the above ten pyrotechnic powders.

4. Based on the formulation of pre-blast products of at least five pyrotechnic powders, list the possible post blast products.

5. Burn samples of the ten powders separately.

Method of Instruction

- Reading literature, practical exercises, and instruction from trainer.

Method of Evaluation

- Written examination, oral questioning, and successful completion of qualifying samples. *A qualifying sample is one or more samples provided to the trainee establishing that the trainee can successfully complete the module, through relevant analytical technique(s).*

Suggested readings:

Davis, TL. The Chemistry of Powder and Explosives, Angriff Press, Hollywood, CA. ISBN 0913022-00-4, Chapter 3 Pyrotechnics.

Weingart, GW. Pyrotechnics, Angriff Press, Hollywood, CA.
Chapters

Chemistry of High Explosives – Inorganic

Objectives:
Upon completion of this unit the student will be able to:

1. Describe at least five types of inorganic high explosives.

2. Explain combustion products of inorganic high explosives.

3. Describe possible uses of inorganic high explosives.

4. Be able to describe methods of preparation inorganic high explosives.

Practical Exercises:

1. By direct visual examination and a stereomicroscope, examine at least ten powders from pyrotechnic devices.

2. Make a list of formulations from the literature of at least 20 pyrotechnic devices including, but not limited to, flash powder, Armstrong's mixture, firecrackers, railroad fusee, road flare, cones/fountains, piccolo/whistling Pete, sparklers, Roman candle and its contents, torpedo/snap pops, smokes & gopher gases, etc.

3. .Using microscopical, instrumental, and/or other analytical techniques, identify components present in the above ten pyrotechnic powders.

4. Based on the formulation of pre-blast products of at least five pyrotechnic powders, list the possible post blast products.

5. Burn samples of the ten powders separately.

Method of Instruction

- Reading literature, practical exercises, and instruction from trainer.

Method of Evaluation

- Written examination, oral questioning, and successful completion of qualifying samples. *A qualifying sample is one or more samples provided to the trainee establishing that the trainee can successfully complete the module, through relevant analytical technique(s).*

Suggested readings:

Davis, TL. The Chemistry of Powder and Explosives, Angriff Press, Hollywood, CA. ISBN 0913022-00-4, Chapter 3 Pyrotechnics.

Weingart, GW. Pyrotechnics, Angriff Press, Hollywood, CA.

Chemistry of High Explosives – Organic

Objectives:
Upon completion of this unit the student will be able to:

1. Describe at least five types of organic high explosives.

2. Explain combustion products of organic high explosives.

3. Describe possible uses of organic high explosives.

4. Be able to describe methods of preparation organic high explosives.

Practical Exercises:

1. By direct visual examination and a stereomicroscope, examine at least ten powders from pyrotechnic devices.

2. Make a list of formulations from the literature of at least 20 pyrotechnic devices including, but not limited to, flash powder, Armstrong's mixture, firecrackers, railroad fusee, road flare, cones/fountains, piccolo/whistling Pete, sparklers, Roman candle and its contents, torpedo/snap pops, smokes & gopher gases, etc.

3. .Using microscopical, instrumental, and/or other analytical techniques, identify components present in the above ten pyrotechnic powders.

4. Based on the formulation of pre-blast products of at least five pyrotechnic powders, list the possible post blast products.

5. Burn samples of the ten powders separately.

Method of Instruction

- Reading literature, practical exercises, and instruction from trainer.

Method of Evaluation

- Written examination, oral questioning, and successful completion of qualifying samples. *A qualifying sample is one or more samples provided to the trainee establishing that the trainee can successfully complete the module, through relevant analytical technique(s).*

Suggested readings:

Davis, TL. The Chemistry of Powder and Explosives, Angriff Press, Hollywood, CA. ISBN 0913022-00-4, Chapter 3 Pyrotechnics.

Weingart, GW. Pyrotechnics, Angriff Press, Hollywood, CA.

Device Reconstruction

(In order to safely perform the following training, it must be conducted under the supervision of qualified personnel)

Non-Blasting Cap Initiated Device Reconstruction

Objectives:

Upon completion of this unit the student will be able to:

1. Recognize device components.
2. Describe the different components used in explosive devices.
3. Describe how a device was constructed.

Practical exercises:

1. Examine a minimum of ten different types of devices, utilizing a low explosive filler and a non-blasting cap initiator, in both pre- and post-blast condition.
2. The devices must have functioned under both ideal and less than ideal conditions.
3. The devices must be constructed utilizing different types of containers, construction and explosive filler.
4. The devices must have been initiated by different types of non-blasting cap initiators. For example these should included cannon fuse, safety fuse and improvised initiators to include both electric and nonelectric types.
5. Describe the characteristics of the remaining device components. These characteristics can include visual observations, odors, measurements, etc.

Method of Instruction:

1. If possible, observe the construction of devices under supervision of qualifed personnel.
2. If possible, recover device debris after initiation of devices by qualifed EOD personnel.
3. Observe and document all surviving device components.
4. Document all unaccounted device components.

Method of Evaluation:

Examine a minimum of six unknown, initiated devices. Identify the remaining components from each device, the explosive filler and determine most probable device construction to include (if possible) the type of initiator used. These unknown devices must include a minimum of two high explosive devices and four low explosive devices.

Blasting Cap Initiated Device Reconstruction

Objectives:

Upon completion of this unit the student will be able to:

1. Recognize device components.
2. Describe the different components used in explosive devices.
3. Describe how a device was constructed.

Practical exercises:

1. Examine a minimum of ten different types of devices, utilizing both high and low explosive fillers and a blasting cap initiator, in both pre- and post-blast condition.
2. The devices must have functioned under both ideal and less than ideal conditions.
3. The devices must be constructed utilizing different types of containers, construction and explosive fillers.
4. The devices must have been initiated by different types of blasting cap initiators. These must include both non-electric and electric blasting caps.
5. Describe the characteristics of the remaining device components. These characteristics should include visual observations, odors, measurements, etc.

Method of Instruction:

1. If possible, observe the construction of devices under supervision of qualifed personnel.
2. If possible, recover device debris after initiation of devices by qualifed EOD personnel.
3. Observe and document all surviving device components.
4. Document all unaccounted device components.

Method of Evaluation:

Examine a minimum of eight unknown, initiated devices. Identify the remaining components from each device, the explosive filler and determine most probable device construction to include (if possible) the type of initiator used. These unknown devices must include a minimum of four high explosive devices, two double-base smokeless powder devices and two low explosive devices.

Pyrotechnic Device Reconstruction

Objectives:

Upon completion of this unit the student will be able to:

1. Recognize device components.
2. Describe the different components used in explosive devices.
3. Describe how a device was constructed.

Practical exercises:

1. Examine a minimum of ten different types of pyrotechnic devices (both commercially and clandestinely produced) in both pre- and post-blast condition.
2. The devices must have functioned under both ideal and less than ideal conditions.
3. The devices must be constructed utilizing different types of containers and explosive fillers. The devices may be obtained commercially or they may be constructed under the supervision of qualified personnel.
4. The devices must have been initiated by different types of initiators.

5. Describe the characteristics of the remaining device components. These characteristics should include visual observations, odors, measurements, etc.

Method of Instruction:

1. If possible, observe the construction of devices under supervision of qualifed personnel.
2. If possible, recover device debris after initiation of devices by qualifed EOD personnel.
3. Observe and document all surviving device components.
4. Document all unaccounted device components.

Method of Evaluation:

Examine a minimum of six unknown, initiated devices. Identify the remaining components from each device, the explosive filler and determine most probable device construction to include (if possible) the type of initiator used.

Electrical Firing Systems Reconstruction

(In this exercise, previously utilized devices may be reused for their components)

Objectives:

Upon completion of this unit the student will be able to:

1. Recognize different types of electrical components.
2. Describe the different electrical components used in explosive devices.
3. Describe how a electrical fusing system was constructed.

Practical exercises:

1. Examine a minimum of ten of each the following:

- different types or brands of batteries in both pre- and post-blast condition.
- different types of wire in both pre- and post-blast condition.
- different types of connectors and/or connections in both pre- and post-blast condition.
- different types of solder/glues/tapes in both pre- and post-blast condition.
- different types of circuitry in both pre- and post-blast condition.
- different types or brands of switches/timers/Radio Control components in both pre- and post-blast condition.

Method of Instruction:

1. If possible, observe the construction of devices under supervision of qualifed personnel.

2. If possible, recover device debris after initiation of devices by qualifed EOD personnel.
3. Observe and document all surviving device components.
4. Document all unaccounted device components.

Method of Evaluation:

Examine eight unknown initiated devices and identify the electrical firing system components from each.

Suggested readings:

1. Anarchists Cookbook
2. Poor Mans James Bond, Vol. I & II
3. Black Book, Vol. I thru III
4. Army Field Manual, Unconventional Warfare Devices
5. Improvised Explosive Devices (IEDs) and Other Criminal and Terrorist Devices – A Basic Reference Manual. (CIA)